

# ADVANCES IN CATARACT SURGERY AND THE MANAGEMENT OF APHAKIA

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**I**N many respects, cataract surgery is the paradigm of modern medical therapy. The operation is among the most commonly performed, it was once considered fraught with hazard but now is a routine—even outpatient—procedure, and the driving force behind recent bold changes in technique is a “final assault” on the technical perfection needed to live up to a patient’s expectations.

## A BRIEF HISTORY

As with many medical procedures, the history of cataract surgery is lengthy, fascinating, and punctuated by an odd balance of brilliant insight and reckless audacity. The goal of the operation is simplicity itself: To remove from the optical axis of the eye a lens that has become opacified and distorts or entirely blocks light on its path toward the retina. An ancient technique, couching,<sup>1</sup> was the first attempt at treating cataract. A needle was introduced into the eye and the lens intentionally subluxated downward, hopefully out of the visual axis. Given the nature of surgical instruments and asepsis 3,000 years ago, one can imagine the inflammations induced. Remarkably, the technique was occasionally successful and remained in wide use right into the 18th century. It is still practiced in parts of the world today.

It was not until the middle of the 18th century that the cornea was incised and the lens actually extracted from the eye. The initial attempts were extracapsular, which means that the posterior lens capsule was left in place to protect the integrity of the intraocular contents. The price paid for this measure of protection was the risk that the posterior capsular membrane itself might block or distort light. Intracapsular lens removal, in which the entire lens is removed exposing the vitreous cavity, was tried later in the 18th century, but did not become widely accepted until our

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time. The debate over these two techniques, as we shall see, continues to the present day.

The modern era of cataract surgery may be roughly dated to the first and second decades of this century. By that time, reliable techniques and instruments were available to anesthetize and to immobilize the globe, to incise the cornea, to perform an iridectomy to prevent postoperative glaucoma, to grasp and to extract the lens, and to suture the wound. Advances during the 1930s, 1940s, and 1950s were more refinement of technique than radical innovation. Enzyme disruption of the lens zonules, cryoprobe extraction, and the entire field of microsurgery with high magnification and ultrathin sutures are among such refinements. With these modalities came the ability to perform safe intracapsular cataract extraction and to open an unobstructed path for light to reach the photoreceptors in the retina. Yet, both surgeons and patients were often dissatisfied with the final optical results.

#### THE PROBLEM

The reason for this dissatisfaction lies in a peculiarity of cataract surgery: The cataract procedure is in a sense only half an operation. The opacified lens is removed, but before vision is restored a new lens must be introduced into the optical pathway. With very few exceptions, the absence of such a postoperative lens renders the eye functionless. Until the 1950s the only available aphakic system was the thick eyeglass lens. However, even when such glasses are correctly prescribed and dispensed, many patients cannot fully adjust to them. The reason is contained in the following formula:

$$\text{Spectacle magnification} = 1/[1-dF]$$

Where

F = lens power

d = distance from lens to eye<sup>2</sup>

Most lenses enlarge (magnify) or reduce ('minify') apparent image size. Aphakic spectacles magnify, and do so to the extent defined by the above equation. Closer inspection of the denominator reveals that as the eyeglass becomes more powerful and sits farther from the eye, the image enlargement becomes greater. The visual disturbances caused by this magnification are considerable because of the high power of aphakic lenses. Without delving into geometric optics, it is intuitively clear that if

the image seen through an aphakic spectacle is expanded 30% (a typical number), then the peripheral 30% of the visual field must be missing. This is exactly the case. Not only do objects appear larger and visual fields restricted with aphakic glasses, but shifting scotomas are formed that move with the patient's gaze and cause objects (e.g., automobiles) to appear suddenly "out of nowhere."

An even more disabling situation is faced by those patients who have had cataract extraction in one eye only. These "monocular aphakes" may accept the aphakic spectacle on one side, but due to the *unilateral* 30% image magnification, they cannot blend vision from the two eyes and thus suffer incapacitating diplopia. With few exceptions, it is impossible for a patient to function with a regular eyeglass in front of one eye and an aphakic lens in front of the other.

In the early decades of this century these optical problems were not insurmountable. Due to less advanced instrumentation, patients often had to wait for cataracts to "ripen," that is, to become more dense. This alleviated the optical problems in two ways. First, the visual deterioration was so great by the time of surgery that *any* optical restoration with glasses was gladly accepted. Second, with such delays it was common for both eyes to become cataractous by the time operation was performed. Often both eyes were operated on during a single hospitalization. Thus the problem of monocular aphakia was avoided.<sup>3</sup>

The modern world of television viewing, highway driving, and gainful employment later in life is quite different. Cataracts can be and are removed at earlier levels of visual impairment, frequently at a time when only one eye is involved. The problems that arise are obvious.

#### THE SOLUTION

Referring back to the formula, it can be seen that to eliminate image magnification one must reduce the denominator to unity. The power [F] of the corrective lens is essentially fixed because it must compensate for the power of the removed natural lens. The only other variable is the distance between the corrective lens and the eye. It is this distance that modern aphakic correction attempts to manipulate.

Initially, distance [d] was reduced by moving the correction back to the cornea in the form of a contact lens. Although this is still a very acceptable rehabilitation for binocular and even monocular aphakia, some problems arise. First, even at the cornea the plane of correction is 5.5 mm anterior to the normal location of the human lens.<sup>4</sup> This results in

image magnification which, though often not troubling, is still in the 7 to 12% range. Second, many if not most elderly cataract patients have difficulty with inserting, removing, and caring for contact lenses. These tasks are often frightening and intimidating and may become totally impossible if tremors, arthritis, or binocular aphakia are present.

Over the last few years, extended wear soft contact lenses have eliminated some of these problems while introducing entirely new ones. Although in theory the "permanent" lenses may be left in place for many months at a time, a sizable percentage of aphakics experience discomfort, fluctuating vision, lens loss, conjunctival injection, and bacterial infection of the cornea.<sup>5</sup> Aphakic soft contact lenses may also interfere with topical drug administration.<sup>6,7</sup>

In an attempt to reduce [d] to zero, the next step was to insert a plastic artificial intraocular lens into the eye at the time of cataract surgery. Actually, this was first tried during the late 1940s by Harold Ridley in England. He is said to have gotten the idea when he noted that polymethyl methacrylate aircraft windshields behaved as inert foreign bodies in the eyes of injured R.A.F. Spitfire pilots.<sup>8</sup> The early intraocular lenses were somewhat crude and the implantation techniques untested. Many of the intraocular lenses implanted during the 1950s actually had to be removed, and there was a very considerable operative risk and complication rate right into the 1960s.<sup>9</sup> Unfortunately, careful planning, quality control, and laboratory animal experimentation were often not a prominent part of the protocols.

By the mid 1970s, intraocular lenses were better designed and the surgical techniques for their implantation had improved. It became clear that meticulous attention to protecting the delicate and critical corneal endothelium might result in less postoperative corneal decompensation, a serious problem often requiring corneal transplantation. The intraocular lens polymers have been improving and becoming less reactive. Intraocular lenses are now less frequently secured to the iris, which often resulted in chronic inflammation and lens dislocation, and are now being placed in the anterior chamber angle with intracapsular extraction and in the posterior chamber with extracapsular surgery.

This latter arrangement is the most physiologic of all, placing the intraocular lens in nearly the exact location of the original lens. As mentioned above, however, a posterior chamber intraocular lens requires that the posterior lens capsule remain intact as support. This capsular membrane can opacify following surgery ("secondary cataract") necessi-

tating a discission operation. More recently, the Neodymium:Yttrium-Aluminum-Garnet laser has been used to open optical paths in the secondary membrane. This powerful new tool is the first medical laser actually to cut by shockwave rather than to cauterize by heat transfer and is one more step in the technical revolution in cataract surgery. It remains to be seen whether this new device will help to eliminate the problem of the secondary membrane and make extracapsular extraction the method of choice.

### SUMMARY

Cataract surgery has come a long way from the initial attempts to sublux the lens out of the optical pathway. I have compressed into a few pages a brief outline of the historical landmarks. Both extended wear soft contact lenses and intraocular lenses now provide excellent visual rehabilitation to hundreds of thousands of patients. New, thinner aphakic spectacles can be used by some patients, and the design of these lenses is improving. The next frontier may be keratorefractive surgery: Patients' own corneas may be augmented by tissue implantation or even removed, frozen, reshaped, and sutured back in place to correct aphakia. This is even now being attempted clinically.<sup>10</sup> The distant future may see the elimination of cataracts altogether. Until then, the bio-optical properties of the human eye and the commonness of the disease seem destined to keep cataract procedures at the forefront of the surgical arts.

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